B4 38P2025

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 406 842 A2**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 90112790.2

(22) Date of filing: 04.07.90

(51) Int. Cl.^{5}: H04L 12/56, H04L 29/06

(30) Priority: 05.07.89 JP 171789/89

(43) Date of publication of application: 09.01.91 Bulletin 91/02

(84) Designated Contracting States: DE FR GB

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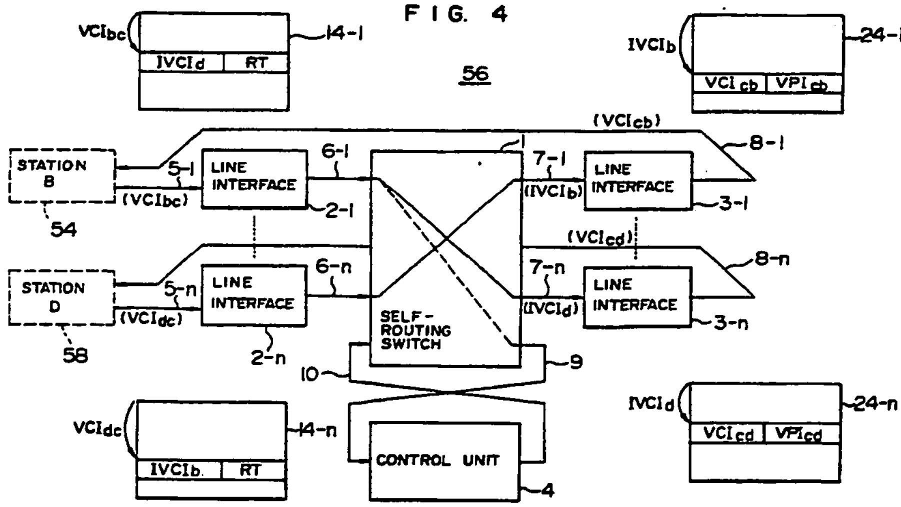
(54) Packet switch network for communication using packet having virtual connection identifier VCI.

(57) In a packet network which includes a plurality of packet switching stations (52, 54, 56, 58) and in which a packet including in its header portion a VPI (Virtual Path Identifier) for identifying one of logical paths multiplexed on a transmission line and VCI (Virtual Connection Identifier) for identifying one of logical connections multiplexed on one logical path is communicated between the switching stations, each switching station preliminarily designates a VCI to be given to a packet directed to that station when a logical connection is to be set up between that station and another station. When receiving an information packet from the other station, the each station makes access to header label conversion tables (14, 24) on the basis of a VCI included in the received packet to read internal routing information necessary for a packet switching operation and a VCI to be given to a packet to be delivered.

FIG. 4



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PACKET SWITCH NETWORK FOR COMMUNICATION USING PACKET HAVING VIRTUAL CONNECTION IDENTIFIER VCI

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a network system including a packet switch, and more particularly to a packet network for communication using a virtual connection identifier and a packet switching system which is applied to such a packet network.

Description of the Related Art

In high-speed packet communication represented by broad band ISDN (BISDN), a self-routing switching system is promising in which a processing for packet switching is realized by means of hardware in order to improve the transmission throughput in a network. An asynchronous transfer mode (ATM) using a packet having a fixed length is one kind of self-routing switching system. In an ATM network as shown by "A DYNAMICALLY CONTROLLABLE ATM TRANSPORT NETWORK BASED ON THE VIRTUAL PATH CONCEPT", GROBECOM '88, 39-2, a plurality of logical paths having their own virtual path identifiers (VPI's) are multiplexed on one real transmission line and a plurality of logical connections between switching stations having their own virtual connection identifiers (VCI's) are multiplexed on each logical path or VPI, in order to economically use a real transmission line having a high data transmission rate and to transmit a communication packet with an excellent reliability. A logical connection between two terminal units communicating with each other through at least one switching station is identified by each switching station by virtue of the combination of VPI and VCI included in the header portion of a received packet, thereby performing a packet switching operation.

One example of an ATM switch using a self-routing switch developed for application to the ATM network has been reported by, for example, "Asynchronous Transfer Mode Experimental switching System for Board Band ISDN", Institute of Electronics, Information and Communication Engineers Technical Report, SSE88-29. In the ATM switch according to this prior art, a label conversion unit having a label conversion table is placed at the front stage of the self-routing switch so that the reference to the label conversion table is made in accordance with a connection identifier included in the header portion of each received packet to read routing information and a new connection identifier which are preliminarily set or written in the label conversion table and are used in the switch, thereby performing the conversion of the header (or label) of the received packet. In the above prior art, however, if VPI and VCI which are an identifier for identifying a call are used as an address of the label conversion table as they are, there arises a problem that the capacity of the label conversion table becomes considerably large.

For example, in the case where a line 60 connected to an A station 52 having a virtual path identifier VPI_{ac} and a line 55 connected to a B station 54 having VPI_{bc} are multiplexed by a multiplexer 71 in a cross connector 61 so that they are inputted to a relay switch (or C station) 56 through one line 70, as shown in Fig. 1, it is necessary to refer to both VPI and VCI included in the header portion of each received packet in order that the switch 56 identifies a logical connection on the line 70. For example, provided that the length of a VPI field of the packet header is 12 bits and the length of a VCI field is 16 bits, a label conversion table having an address capacity of 2^{28} = 256 Mbits is required in the switch 56. This means that the total memory capacity of the label conversion table amounts to the order of G bits. Therefore, it is difficult to realize such a switching network.

Also, in the self-routing switch, it is necessary to preliminarily set routing information RT representive of the output line number of the switch in addition to ordinary packet information for each packet in order to switch an input packet to an output line coincident with a logical connection. In the conventional switch, the addition of the routing information RT gives rise to a problem that the length of a packet in the switch becomes large and hence the improvement of a data processing speed in the switch (or a speed conversion) is required in order to ensure the same throughput at the input and output sides of each switch.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a packet switch system and a packet switching method in which the capacity of a table memory for conversion of the header of a received packet can be reduced even if a plurality of logical paths are multiplexed on the same transmission line.

Another object of the present invention is to provide a packet communication network which is capable of making the size of a packet transmitted

in a switch and the size of a packet transmitted on a line outside the switch identical with each other.

To attain the above object, one feature of a packet switch network according to the present invention lies in that an information transfer logical connection having an asymmetrical VCI the value of which differs depending on the direction of transmission of an information packet is formed between two switching stations which communicate with each other. In this case, any given one of the switching stations upon call set-up designates to the preceding or succeeding switching station the value of VCI which the preceding or succeeding station is to give to an information packet directed to the given station from the preceding or succeeding station. Namely, in the present invention, each of switching stations constructing the network operates so as to receive a packet which has in a header portion thereof a VCI designated by itself (or that switching station) and to deliver a header label converted packet which includes a VCI designated by the other switching station. Accordingly, for example, in the network, as shown in Fig. 1, in which a packet delivered from the A station 52 and a packet delivered from the B station 54 are inputted to the C station 56 in a form in which the packets are multiplexed on the common transmission line 70, the present invention allows the C station 56 to determine a CVI to be given to a received packet at every call so that the packet received from the A station 52 and the packet received from the B station 54 always have different VCI's, thereby making it possible to identify a logical connection of each packet by only the VCI. As a result, the address capacity of a label conversion table necessary for rewrite of a header label of the received packet can be suppressed to the number of VCI's (for example, 2^{16} = 64 K).

Another feature of the present invention lies in that a packet label converting function at each switching station is divisionally arranged in front of and in rear of a switch unit so that an incoming line interface functions to remove a VPI which is included in a packet received from the preceding switching station and becomes unnecessary for a packet switching operation in the switch is eliminated at an incoming line interface and thereinstead to insert routing information RT used in the switch and an outgoing line interface gives a VPI again to a packet to be delivered after the packet switching operation has been finished. For example, an internal VCI and routing information used in the switch are set in an input side label conversion table, and a VCI and a VPI for the outgoing line are set in an output side label conversion table. In the input side, a VCI is converted into the internal VCI while the routing information for the switch is set to a VPI field of the packet header. In the output side, the internal VCI is converted into the VCI for the outgoing line while the VCI is given to the packet header.

With the above construction, since it is possible make the sizes of packets inside and outside the switching station identical with each other, it is not necessary to provide a specific speed conversion function for absorbing a difference in packet length.

The foregoing and other objects, advantages, manner of operation and novel features of the present invention will be understood when reading the following detailed description in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block daigram showing an example of a packet network configuration to which the present invention is applicable;

Figs. 2, 3A and 3B are diagrams for explaining examples of the general construction of a network to which the present invention is applicable;

Fig. 4 is a block diagram showing the overall construction of a packet switch according to the present invention;

Figs. 5A to 5C are views for explaining the format of an information packet and a header conversion performed by a switch;

Figs. 6A and 6B are views for explaining the formats of control signal packets used for undating of label conversion tables in a switch;

Fig. 7 is a block diagram showing an example of the construction of an incoming line interface 2-i and an outgoing line interface 3-i shown in Fig. 4;

Fig. 8 is a block diagram showing an example of the construction of a control unit 4 shown in Fig. 4;

Fig. 9 is a view showing an example of a packet communication sequence according to the present invention;

Fig. 10 is a flow chart showing a control operation sequence which the control unit 4 of the switch performs upon receive of an IAM signal packet in Fig. 9; and

Fig. 11 is a flow chart showing a control operation sequence which the control unit 4 of the switch performs upon reception of an ACM signal packet.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 2 shows the general construction of a network to which the present invention is applica-

ble. The network for making a connection between terminal 51 (51a to 51n) and terminals 59 (59a to 59m) includes local switches 52 and 58 for accommodating the terminals 51 and 52, a relay line 55, and relay stations 54 and 56 for communizing the relay line 55 between the local switches 52 and 58 to enhance the traffic processing efficiency.

As regards a high-traffic route, a line 60 may be additionally provided between the switches 52 and 56, as shown in Fig. 3A, thereby reducing a load of the relay station 54.

Fig. 3A shows an example of a physical line construction for realizing the network shown in Fig. 3A. In this example, a transmission line including the lines 60, 53 and 55 is communized and is distributed by a cross connector 61 to a line which arrives at the relay station (or B station) 54 and a line which makes a relay to the relay station (or C station) 56. In the packet network, a unit for identifying a group of logical lines having the same packet transmission direction is given as a virtual path indicator or identifier (VPI) to a packet header. The VPI is defined for each line and in each direction thereof, as (VPI_{ab}, VPI_{ba}) for the line 53, VPI_{bc}, VPI_{cb}) for the line 55 and (VPI_{ac}, VPI_{ca}) for the line 60 in Fig. 3B. The cross connector 61 distributes each received packet to one of output paths by virtue of the VPI.

Fig. 1 corresponds to Fig. 3B and shows the cross connector 61 in more detail. The line VPI_{ac} from the A station 52 and the line VPI_{bc} from the B station 54 are packet-multiplexed in the cross connector 61 and are thereafter inputted to one line of the C station 56.

Fig. 4 shows an example of the construction of a self-routing switch system 56 to which the present invention is applied. The present switch system includes a self-routing switch 1 which accommodates n lines therein and performs a packet switching operation, incoming line or input side interfaces 2 (2-1 to 2-n) which are respectively provided for incoming lines 5 (5-1 to 5-n) respectively, outgoing line or output side interfaces 3 (3-1 to 3-n) which are respectively provided for outgoing lines 8 (8-1 to 8-n), and a control unit 4 which performs a call processing. Each incoming line interface 2-i is provided in front of the self-routing switch 1 with an input thereof being connected to one incoming line 5-i and with an output thereof being connected to an input line 6-i of the self-routing swich 1. By virtue of an input side label conversion table 14-i, each incoming line interface 2-i has a function of converting a virtual logical identifier VCI (or first VCI) in the header portion of an input packet into an internal VCI (IVCI) which is used in the switch and is provided corresponding to each of output lines of the self-routing switch 1 and giving routing information RT indicative of an output line number of the switch 1 to the header portion of the packet. Each outgoing line interface 3-i is provided in rear of the self-routing switch 1 with an input thereof being connected to the output line 7-i of the switch 1 and with an output thereof being connected to the outgoing line 8-i. By virtue of an output side label conversion table 24-i, each outgoing line interface 3-i has a function of converting the IVCI into an outgoing VCI (or second VCI) and giving a virtual path identifier (VPI). Instead of using the internal VCI (IVCI), the first VCI may be used as an address to read the second VCI. The control unit 4 has an input connected to one output line 9 of the switch 1 and an output connected to one input line 10 of the switch 1.

Figs. 5A to 5C show the formats of signal packets for general information. The packet is composed of a header portion H (H1 to H3 fields) and an information portion or user portion INFO. A packet inputted from the incoming line 5-i to the line interface 2-i includes an incoming VPI (VPI_i) in an H1 field and an incoming VCI (VCI_i) in an H2 field, as shown in Fig. 5A.

A packet flowing on the signal lines 6, 7, 9 and 10 includes a number (or routing information) RT indicative of the output line 7-j or 9 of the switch 1 in an H1 field and an internal VCI ($IVCI_o$) given corresponding to the output line 7-j or 9 in an H2 field, as shown in Fig. 5B.

A packet outputted from the line interface 3-j to the outgoing line 8-j includes an outgoing VPI (VPI_o) in an H1 field and an outgoing VCI (VCI_o) in an H2 field, as shown in Fig. 5C.

In the example shown in Fig. 4, the switch 56 corresponds to the C station shown in Fig. 3B, VCI_i and VPI_i of the incoming line 5-1 connected to the B station 54 are assumed as VCI_{bc} and VPI_{bc} respectively, VCI_i and VPI_i of the incoming line 5-n connected to the D station 58 are assumed as VCI_{dc} and VPI_{dc} respectively, VCI_o and VPI_o of the outgoing line connected to the B station 54 are assumed as VCI_{cb} and VPI_{cb} respectively, and VCI_o and VPI_o of the outgoing line 8-n connected to the d station 58 are assumed as VCI_{cd} and VPI_{cd} respectively.

Figs. 6A and 6B show the formats of internal control signal packets generated by the control unit 4. Fig. 6A shows the format of a packet for setting (or write) of data to the output side label conversion table. An H1 field is set with an output line number RT, an H2 field is set with VCI_{eo} allotted to the output side label conversion table, and fields P1, P2 and P3 of a user portion are respectively set with VPI_o and VCI_o to be written in the output side label conversion table 24 and an write address $IVCI_o$ of the output side label conversion table. Fig. 6B shows the format of a packet for setting (or write) of data to the input side label conversion

table. An H1 field is set with an outgoing line number RT, and H2 field is set with VCI_{ei} allotted to the input side label conversion table, and fields P1, P2 and P3 are respectively set with rT and $IVCI_o$ to be written in the input side label conversion table and a write address VCIi.

Fig. 7 shows the details of the incoming line interface 2-i and the outgoing line interface 3-i.

Referring to Fig. 7, the incoming line 5-i is connected to an input register 12 and through a delay circuit 11 to an output register 13. VCI of packet information inputted to the input register 12 is taken from the H2 field of the input packet into a signal line 15 and is inputted as a read address ot an input side label conversion table 14-i. A data output line 16 of the input side label conversion table 14-i is connected to the output register 13 an output of which is inputted to the self-routing switch 1 through a signal line 6-i.

On the other hand, the output line 7-i of the switch 1 is connected to an input register 22 and through a delay circuit 21 to an output register 23. The contents of the H2 field in packet information inputted to the input register 22 are inputted to a separator circuit 26 through a signal line 112 and the contents of the P1 to P3 fields in the inputted packet are outputted onto a signal line 29.

The separator circuit 26 outputs an enable signal to a signal line 113 in the case where the contents of the H2 field are VCI_{ei} or to a signal line 114 in the case where the contents of the H2 field are VCI_{eo}, so that a gate 116 or 117 is open. Thereby, in the case where a packet received from the switch 1 is a packet for setting of data into the input side label conversion table (see Fig. 6B), the contents (RT, $IVCI_o$, VCI_i) of the P1 to P3 fields of the received packet are inputted through the gate 116 to transmission register 25 from which VCI_i is ouputted to a write address line 28 of the input side label conversion table 14-i and RT and $IVCI_o$ are outputted to a data line 27, thereby effecting the setting of table data, as shown in the tables 14-1 to 14-n of Fig. 4. In the case where the received packet is a packet for setting of data into the output side label conversion table (see Fig. 6A), the contents (VPI_o, VCI_o) of the P1 and P2 fields are inputted to a data line of the output side label conversion table through the gate 117 and the contents ($IVCI_o$) of the P3 field are inputted to a write address line of the output side label conversion table, thereby effecting the setting of table data, as shown in the tables 24-1 to 24-n of Fig. 4. In the case where the received packet is a general information packet (see Fig. 5B), $IVCI_o$ is outputted from the separator circuit 26 to a read address line 115 so that VPI_o and VCI_o corresponding to $IVCI_o$ are read from the output side label conversion table 24-i onto a data line 111 and the output register 23 outputs to an outgoing line 8-i a header-converted packet which has a format as shown in Fig. 5C.

Fig. 8 shows the details of the construction of the control unit 4 shown in Fig. 4. The input line 9 is connected to an input register 32 and through a delay circuit 31 to an output register 42. IVCI extracted from the H2 field in a received packet (see Fig. 5B) inputted to the input register 32 is inputted as a read address to a distribute table 33 through a signal line 3. An incoming line number LN corresponding to $IVCI_o$ which the line interface 2-i gives to the packet directed to the control unit is store din the table 33 and LN read from the table 33 is inputted to a distributer circuit 35 through a signal line 40. The distributer circuit 35 inputs the received packet out-putted from the output register 42 to one of a plurality of signal processing units 36-1 to 36-n which makes a one-to-one correspondence to an incoming line 5 selected in accordance with LN. Outputs of the signal processing units 36-1 to 36-n are concentrated by a concentrater circuit 38 and are connected to the input line 10 of the switch 1. Each signal processing unit is connected through a bus 42 to a central control unit 37 which performs a call processing.

Next, the operation of the above-mentioned packet switching system according to the present invention will be explained in reference with Figs. 9 to 11.

Stations A, B, C and D in Fig. 9 correspond to the stations 52, 54, 56 and 58 in Fig. 3B. The switching operation of the C station will be explained taking as example of a signal sequence a call which arrives the C station through the relay line 55 from the B station and thereafter goes to the D station and a call which arrives the C station through the oblique line 60 from the A station and thereafter goes to the D station.

When a call going to the D station through the C station is generated at the B station, the B station transmits to the c station an initial address message (IAM) 81 which is a signal to request a call set-up. In the signal notation in Fig. 9, values in the H1 and H2 fields of a header portion are shown in a bracket [ ] and parameter included in an information portion INFO are shown in a pharenthesis ( ). Accordingly, the signal packet of IAM 81 includes VPI_{bc} and VCI_s allotted to the signal packet in the header portion and includes VCI_{cb} and a dial number DN as the parameters in the information portion. In the following, the operation of the C station 56 upon and after arrival of the IAM 81 to the C station 56 will be explained in due succession.

[Call Set-Up Phase: I]

The IAM signal packet 81 is inputted to the line interface 2-1 from the line 5-1 (see Fig. 4) connected to the B station 54. In the line interface 2-1, the packet is inputted to the input register 12 shown in Fig. 7 so that VCI_s extracted from the H2 field of the packet header portion is used as an address to make access to the input side label conversion table 14-1. In a memory region of the conversion table 14-1 at the address VCI_s is set or written a record including RT indicative of the output line 9 to which the control unit 4 is connected and IVCI having a value which is allotted corresponging to the incoming line 5-1. RT and IVCI read from the table 14-1 through the above-mentioned access are supplied through the data line 16 to the output register 13 in which they are inserted into the packet header portion. The self-routing switch 1 outputs the packet received from the input line 6-1 to the output line 9 in accordance with RT included in the header of the packet.

The packet arriving the control unit 4 through the line 9 is inputted to the input register 32 (shown in Fig. 8) in which $IVCI_o$ is extracted from the H2 field of the header portion of the packet. The value of $IVCI_o$ is outputted onto the data line 39 and is used as an address to make access to the distribute table 33. The distribute table 33 outputs to the data line 40 an incoming line number LN which corresponds to IVIC given by the line interface 2-1. Based on the information (LN) supplied from the data line 40, the distributer circuit 45 distributes the packet to one of the signal processing units 36-1 to 36-n. The signal processing unit (36-1 ~ 36-n) performs a signal processing which includes, for example, a segmenting/reassembling process (or adaptation layering process) and LAPD (LINK Access Procedure on the D-Channel) and sends a message assembled from the received packet to the central control unit 37. Thereafter, an IAM receive processing program 200 at the central control unit 37 is activated.

Fig. 10 shows the flow of a processing by the IAM receive processing program 200. In the IAM receive processing, vacant information VCI (VCI_{bc} in the shown example) for allotment to the incoming line 5-1 connected to the B station 54 which is a start station is hunted (step 202). Also, an internal VCI ($IVCI_b$ in the shown example) for outputting a packet to be directed to the B station to the output line 7-1 of the switch 1 is hunted (step 204).

Next, a dial number DN included as a parameter in the IAM signal packet is extracted and is subjected to numerical translation to determine an outgoing line number VPI_{cd} (the outgoing line 8-n to the D station 58) (step 206). Further, information VCI_{dc} to be allotted to the incoming line 5-n connected to the D station and paired with the outgoing line 8-n is hunted (step 208) and $IVCI_d$ for the output line 7-n of the switch 1 is hunted (step 210).

The success of all of the above VCI, VPI and IVCI is followed by a processing for transmitting an IAM signal 82 to the D station. First, VCI_s and VPI_{cd} are set or written at an address IVCI of the output side label conversion table 24-n in the line interface 3-n of the outgoing line 8-n connected to the D station (step 212). This data setting operation is performed by transmitting an internal signal packet (see Fig. 6A) from the control unit 4 to the line interface 3-n through the line 10, the switch 1 and the line 7-n. The H1 field of the internal signal packet is set with routing information RT indicative of the outgoing line 7-n, the P1 and P2 fields thereof are set with VPI_{cd} and VCI_s which are information to be written, and the P3 field thereof is set with IVCI which corresponds to an address of the label conversion table 24-n.

Next, the IAM signal packet 82 is transmitted to the D station (step 214). The IAM signal packet 82 includes, in its H1 and H2 fields, RT indicative of the output line 7-n of the switch 1 corresponding to the outgoing line 8-n connected to the D station and IVCI, respectively and the user portion INFO of the IAM signal packet is set with a signal name IAM, VIC_{dc} as a parameter and DN which is a terminal number in the D station. The packet is inputted to the line interface 3-n through the line 10, the switch 1 and the line 7-n. In the line interface 3-n, the H2 field of the packet header portion is extracted in the input register 22 shown in Fig. 7 and the extracted value IVCI is inputted to the output side label conversion table 24 through the address line 115. Thereby, the conversion table 24 outputs VPI_{cd} and VCI_s to the output register 23 through the data line 111. The output register 23 inserts the received information (VPI_{cd} and VCI_s) into the header portion of the IAM packet and transmits the header-converted IAM packet to the line 8-n connected to the D station.

Finally, the values of VPI_{bc}, VPI_{cb}, VPI_{cd}, VCI_{bc}, VCI_{cb}, VCI_{dc}, $IVCI_b$ and $IVCI_d$ are stored (step 216). VPI_{cb} is determined by conversion from VPI_{bc}.

In Fig. 9, when the C station 56 receives through the line 5-n a call set-up completion signal ACM (Address Complete Message) 83 (including VPI_{dc} and VCI_s in its header portion and information VCI_{cd} indicative of the direction from the C station to the D station as a parameter in its user portion) outputted from the D station 58, the call set-up completion signal ACM 83 arrives the control unit 4 through the line interface 2-n, the self-routing switch 1 and the line 9, line upon reception of the IAM signal, and an ACM receive processing program 300 shown in Fig. 11 is activated in the central control unit 37. In this case, since the call set-up compeltion signal ACM has been returned

from the D station of destination of the call, the following processing is performed for call set-up between the C station and the B station and between the C station and the D station.

First, VCI_{cd} and VPI_{cd} are set at an address $IVCI_d$ of the output side label conversion table 24-n in the line interface 3-n of the outgoing line 8-n connected to the D station (step 302). The setting of data into the output side label conversion table 24-n is effected by transmitting an internal signal packet (having a format shown in Fig. 6A) from the control unit 4 to the line interface 3-n through the line 10, the switch 1 and the line 7-n. The H1 field of the internal signal packet is set with RT indicative of the output line 7-n connected to the line interface 3-n, the H2 field thereof is set with VCI_{eo}, the P1 and P2 fields thereof are set with VPI_{cd} and VCI_{cd}, and the P3 field thereof is set with $IVCI_d$ which is an address of the table 24-n.

In the line interface 3-n, when the internal signal packet is received, VCI_{eo} identified by the separator circuit 26 and P1, P2 and P3 from the input register 29 are inputted to the output side conversion table 24 through the gate 117. Thereby, in the label conversion table 24, the contents VPI_{cd} of the P1 field and the contents VCI_{cd} of the P3 field are set at the address indicated by $IVCI_d$ included in the P3 field.

Next, $IVCI_b$ and routing information RT indicative of the output line 7-1 corresponding to the B station are set at an address VCI_{dc} of the input side label conversion table 14-n in the line interface 2-n connected to the incoming line 5-n from the D station (step 304). The setting of data to the input side label conversion table 14-n is made by transmitting an internal signal packet in a format shown in Fig. 6B from the control unit 4 to the outgoing line interface 3-n corresponding to the incoming line interface 2-n through the line 10, the switch 1 and the line 7-n. The H1 field of the resultant packet is set with RT indicative of the output line 7-n, the P1 and P2 fields thereof are set with RT indicative of the output line 7-1 corresponding to the B station and $IVCI_b$, and the P3 field thereof is set with a table address VCI_{dc}.

In the outgoing line interface 3-n, since VCI_{ei} is identified by the separator circuit 25, the contents of the P1, P2 and P3 fields extracted by the input register 22 are inputted to the transmission register 25. Thereby, the contents RT of the P1 field and the contents $IVCI_b$ of the P2 field are set at an address VCI_{dc} of the input side label conversion table 14. Similarly, VCI_{cb} and VPI_{cb} are set at an address $VICI_b$ of the output side label conversion table 24-1 in the outgoing line interface 3-1 connected to the B station (step 306), and $IVCI_d$ and RT indicative of the output line 7-n corresponding to the D station are set at an address VCI_{bc} of the input side label conversion table 14-1 in the incoming line interface 2-1 connected to the B station (step 308).

Finally, an ACM signal packet 84 including VPI_{cb} and VCI_s in its header portion and VCI_{bc} in its user portion is transmitted to the B station (step 310).

[Information Transmit Phase: II]

The following explanation will be made of the switching operation of the C station when a data packet 85 of a format of fig. 5A having VPI_{bc} and VCI_{bc} in its header portion arrives the C station from the B station after the call has been set up.

The packet 85 is inputted to the line interface 2-1 through the incoming line 5-1. Then, the H2 field of the received packet is extracted by the input register 12 shown in Fig. 7 and the value of the H2 field or an address VCI_{bc} is supplied to the input side label conversion table 14-1 through the address line 15. Since $IVCI_d$ and the routing information RT indicative of the output line 7-n of the switch 1 are set at an address position of the conversion table 14-1 indicated by VCI_{bc} upon call set-up, these information are read to the output register 13 through the data line 16 so that the received packet is subjected to header conversion to provide a format as shown in Fig. 5B. The packet arrives the line interface 3-n through the self-routing switch 1 and the line 7-n in accordance with RT of the header portion. In the line interface 3-n, the H2 field of the received packet is extracted by the input register 22 shown in Fig. 7 and the value $IVCI_d$ of the H2 field is inputted as an address to the output side label conversion table 24-n through the signal line 112, the separator circuit 26 and the data line 115. Since VCI_{cd} and VPI_{cd} are set at an address of the conversion table 24-n indicated by $IVCI_d$ upon call set-up, these information are read to the output register 23 through the data line 111 and are inserted into the header portion of the packet 85 and the resultant packet is transmitted as a data packet 86 to the outgoing line 8-n connected to the D station.

In the case where a data packet 87 having VPI_{dc} and VCI_{dc} in its header portion arrives the C station from the D station, the received packet is inputted to the incoming line interface 2-n through the incoming line 5-n, in a manner similar to that mentioned above. In the line interface 2-n, VCI_{dc} extracted from the H2 field of the received packet 87 is supplied as an address to the input side label conversion table 14-n. Since $IVCI_b$ and the routing information RT indicative of the output line 7-1 are set at an address position of the conversion table 14-n indicated by VCI_{dc} upon call set-up, these

information are read to the output register 13 through the data line 16 and are inserted into the header portion of the packet 87. The thus header-converted packet arrives the outgoing line interface 3-1 through the self-routing switch 1 and the line 7-1 in accordance with RT of the header portion. In the line interface 3-1, $IVCI_b$ extracted from the H2 field of the received packet is supplied as an address to the output side label conversion table 24-1 throuth the signal line 112, the separator circuit 26 and the address line 115. Since VCI_{cb} and VPI_{cb} are set at an address position of the conversion table 24-1 indicated by $IVCI_b$ upon call set-up, these information are read to the output register 23 through the data line 111 and are inserted into the header portion of the received packet 87 and the resultant packet is transmitted as a data packet 88 to the outgoing line 8-1 connected to the B station.

Also in the case where a start signal or call set-up requesting signal IAM 89 from the A station 52 arrives the C station, an operation similar to the above-mentioned operation is performed for both a call set-up phase (I) and an information transmit phase (II), as shown by 90 to 96 in Fig. 9. Also, even in the case of a network construction in which the line 60 from the A station and the line 55 from the B station are multiplexed and are inputted as one line to the switch, as shown in Fig. 1, VCI_{ac} and VCI_{bc} are different from each other since VCI of the receiving side is hunted among vacant VCI's in the IAM receive processing 200. Therefore, it is possible to identify a connection by only VCI. For the above reason, each label conversion table in the switch can be constructed to have addresses the number of which corresponds to the number of VCI's.

Claims

1. A packet network comprising a plurality of packet switching stations (52, 54, 56, 58), in which a packet including in its header portion a virtual connection identifier for identifying a logical connection which determines a transmission route of the packet is communicated between the packet switching stations, any given one of said packet switching stations comprising:

means (1, 2, 3, 4) for determining, when a logical connection is set up between said given packet switching station and any one of the other packet switching stations, a first virtual connection identifier to be given to each information packet subsequently transmitted from said other packet switching station by use of the logical connection and informing said other packet switching station of said first virtual connection identifier by a control packet; and

means (1, 2, 3, 4) for giving, when said given packet switching station transmits an information packet to said other packet switching station, a second virtual connection identifier preliminarily designated from said other packet switching station to said each information packet and delivering the resultant information packet onto an outgoing line to which said other packet switching station is connected.

2. A packet network according to Claim 1, wherein said each packet includes in its header portion a virtual logical path identifier for identifying a logical path including a plurality of multiplexed logical connections having the same packet transmission direction, and wherein said given packet switching station includes:

a plurality of incoming lines (5) and a plurality of outgoing lines (8) respectively connected to the other packet switching stations;

switch means (1) connected between said incoming lines and said outgoing lines, said switch means operating to output an input packet to either one of said outgoing lines in accordance with routing information given to the input packet; and

label conversion means (2, 3) for giving routing information to a received packet inputted to each of said incoming lines to said switch means to input the resultant packet to said switch means and removing said routing information from a packet outputted from said switch emans, said routing information being determined in accordance with the first virtual connection identifier included in the received packet.

3. A packet network according to Claim 2, wherein said label conversion means (2, 3) includes a plurality of first label conversion means (11, 12, 13, 14) respectively provided for said incoming lines and a plurality of second label conversion means (22, 23, 24, 25, 26) respectively provided for said outgoing lines (8), each of said plurality of first label conversion means including first table means (14) for storing routing information in correspondence to a first virtual connection identifier to be included in each packet received from the incoming line connected to the first label conversion means and first control means (13) for rewriting the virtual logical path identifier field included in each received packet to be set with the routing information read from said first table means and inputting the resultant packet to said switch means, and each of said second label conversion means including second table means (24) for storing, a virtual logical path identifier which is to be removed from each received packet prior to the inputting of the packet to said switch means and a second virtual connection identifier which is to be given to an output packet and is preliminarily designated from the other packet switching station, in cor-

respondence to a first virtual connection identifier to be included in each received packet and second control means (23) for rewriting a virtual connection identifier field and a routing information field included in the packet outputted from said switch means to be respectively set with the second virtual connection identifier and the virtual logical path identifier read from said second table means.

4. A packet network according to Claim 3, wherein an internal virtual connection identifier is stored together with said routing information in each of said first table means (14) in correspondence to each first vurtual connection identifier, said first control means (13) rewrites the virtual connection identifier field and a virtual logical path identifier field included in said received packet to be respectively set with the internal virtual connection identifier and the routing information read from the first table means, said virtual logical path identifier and said second virtual connection identifier are stored in each of said second table means (24) in correspondence to said internal virtual connection identifier, and said second control means (23) reads one pair of the virtual logical path identifier and the second virtual connection identifier from said second table means in accordance with the internal virtual connection identifier included in the packet outputted from said switch means (1).

5. A method of communicating a packet in a network which includes a plurality of switching stations (52, 54, 56, 58), the packet including in its header portion a virtual path identifier for identifying one of logical paths multiplexed on one transmission line and a virtual connection identifier for identifying one of logical connections multiplexed on one logical path, said method comprising in any given one of the plurality of switching stations:

a first step of designating a virtual connection identifier to be given to an information packet subsequently transmitted to said given switching station from any one of the other switching stations by virtue of a control packet communicated for setting up a logical connection; and

a second step of setting, after the logical connection has been set up, the virtual connection identifier designated by any one of the switching stations other than said given switching station in said first step to a vritual connection identifier field of an information packet which is generated by said given switching station or is received from said one of the other switching stations and is to be transmitted to said one of the other switching stations, and delivering the resultant packet onto a predetermined transmission line which is connected to said one of the other switching stations.

6. A method according to Claim 5, wherein each of said plurality of switching stations includes a plurality of incoming lines (5) respectively connected to the other switching stations, input side interfaces (2) respectively provided for said incoming lines, a plurality of outgoing lines (7) respectively connected to the other switching stations, output side interfaces (3) respectively provided for said outgoing lines, and a switch (1) provided between said input side interfaces and said output side interfaces, wherein said first step includes a step of storing, routing information for specifying one of the outgoing lines onto which a control packet delivered from any one of the other switching stations is to be delivered, into a memory (14) of one of the input side interfaces which receives a control packet delivered from said either one of the other switching stations, in correspondence to a first virtual connection identifier field of said control packet and a step of storing, a virtual path identifier set in a virtual path identifier field of said received control packet and a second virtual connection identifier set in a data field of said received control packet, into a memory (24) of one of the output side interfaces which is connected to the one outgoing line specified by said routing information, in correspondence to said first virtual connection identifier, and wherein said second step includes a step of reading, in the input side interface which receives an information pakcet delivered from either one of the other switching stations, routing information corresponding to a first virtual connection identifier included in a virtual connection identifier field of said information packet from the memory of the input side interface and giving the read routing information to a virtual path identifier field of said information packet, a step of switching an information packet outputted from said input side interface to one of the output side interfaces in accordance with said routing information, and a step of reading, in said one output side interface which receives said information packet, a virtual path identifier and a second virtual connection identifier corresponding to the first virtual connection identifier included in the virtual connection identifier field of said information packet from the memory of said one output side interface and giving the read virtual path identifier and second virtual connection identifier to the virtual path identifier field and the virtual connection identifier field of said information packet, respectively.

7. A method according to Claim 6, wherein in said storing step performed in said input side interface (2) an internal virtual connection identifier is stored together with said routing information into the memory (14) of said output side interface in said storing step performed in said output sdie interface (3) said virtual path identifier and said second virtual connection identifier are stored into the memory (24) of said output side interface, in correspondence to said internal virtual connection identifier

substituted for said first virtual connection identifier, in said giving step performed in said input side interface the routing information and the internal connection identifier are read from the memory of said input side interface and said internal virtual connection identifier is given to the virtual connection field of the information packet, and in said giving step performed in said output side interface the virtual path identifier and the second virtual connection identifier corresponding to the internal virtual connection identifier included in the vritual connection identifier field of the information packet are read.

FIG. 1 PRIOR ART

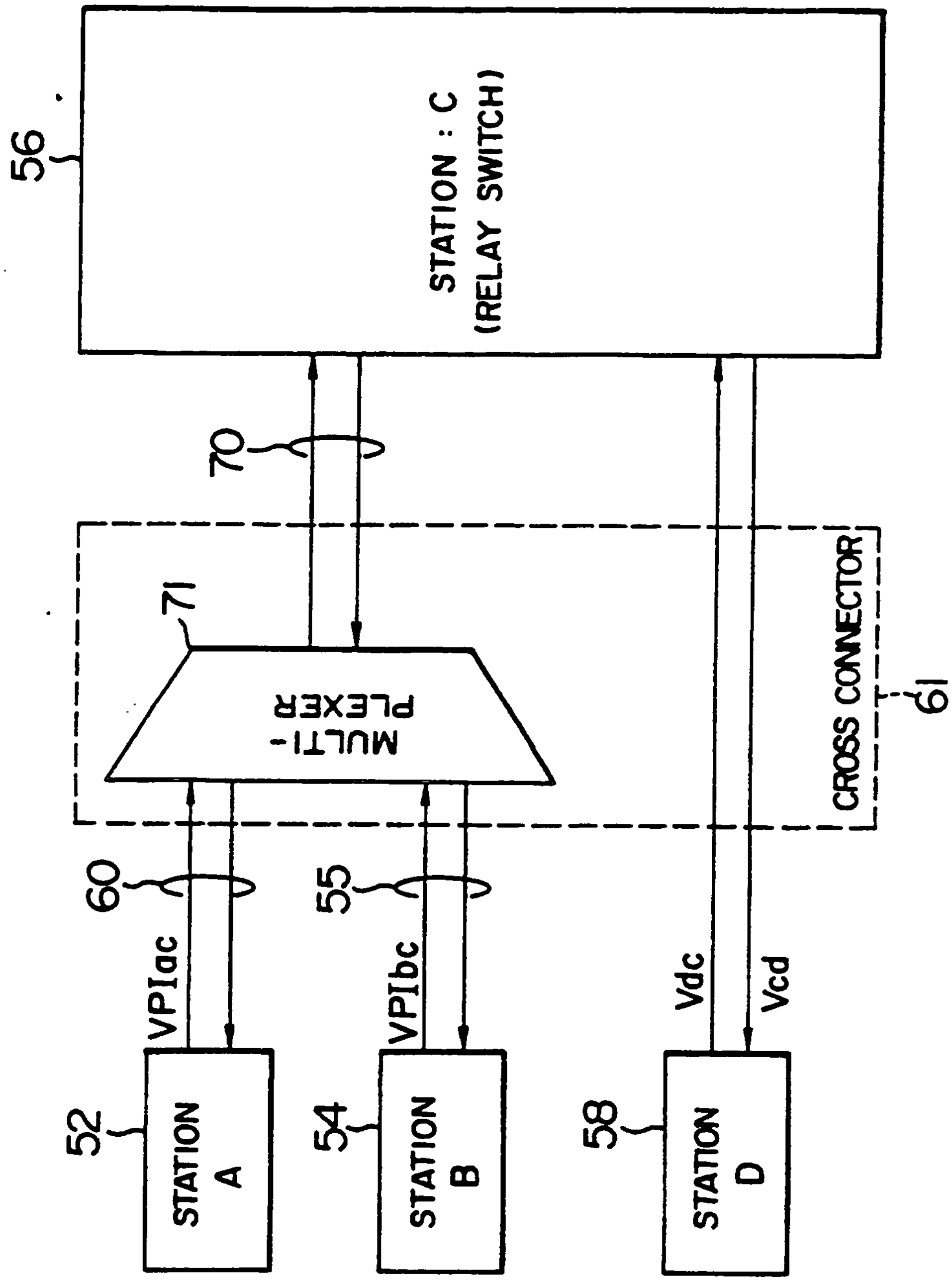


FIG. 2

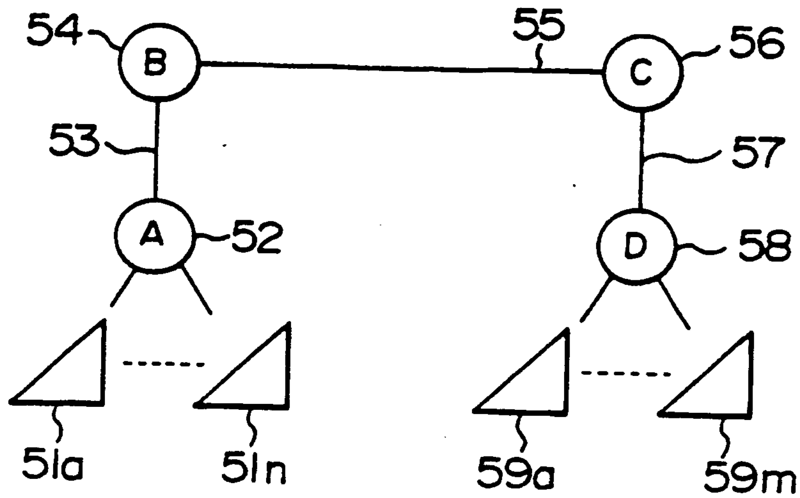


FIG. 3A

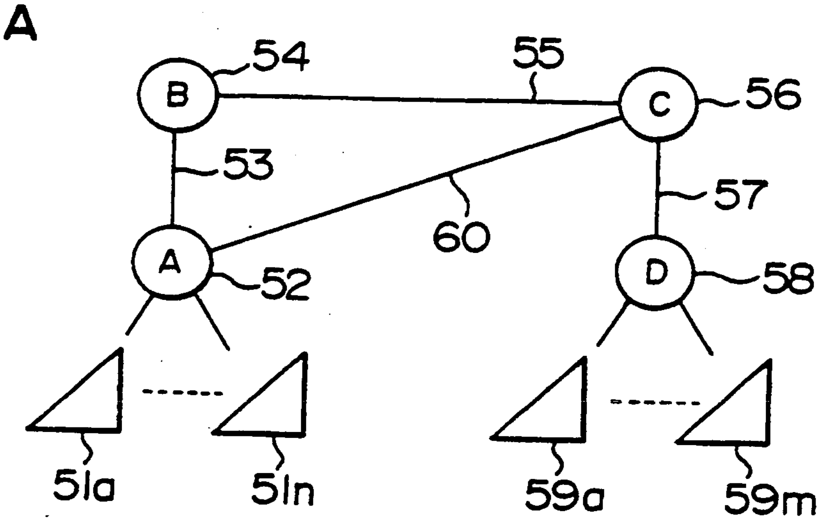
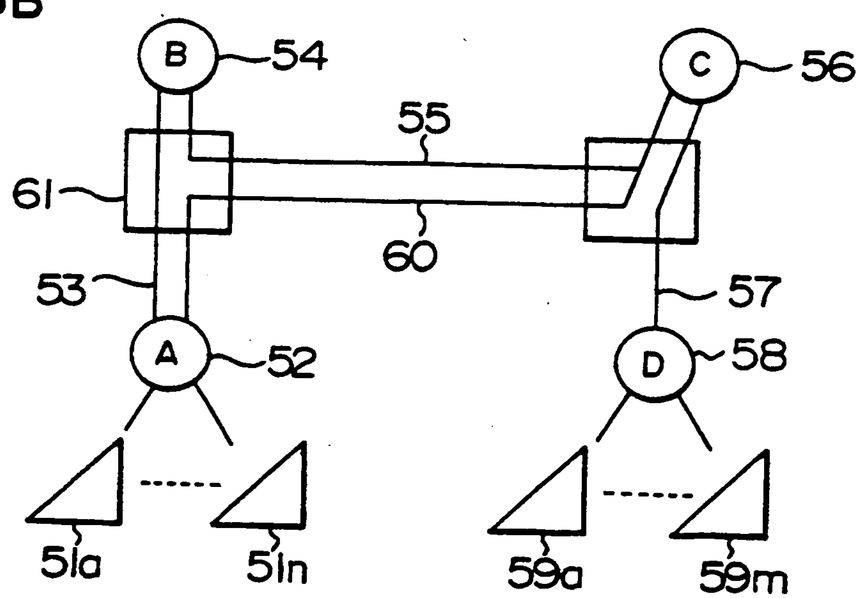


FIG. 3B



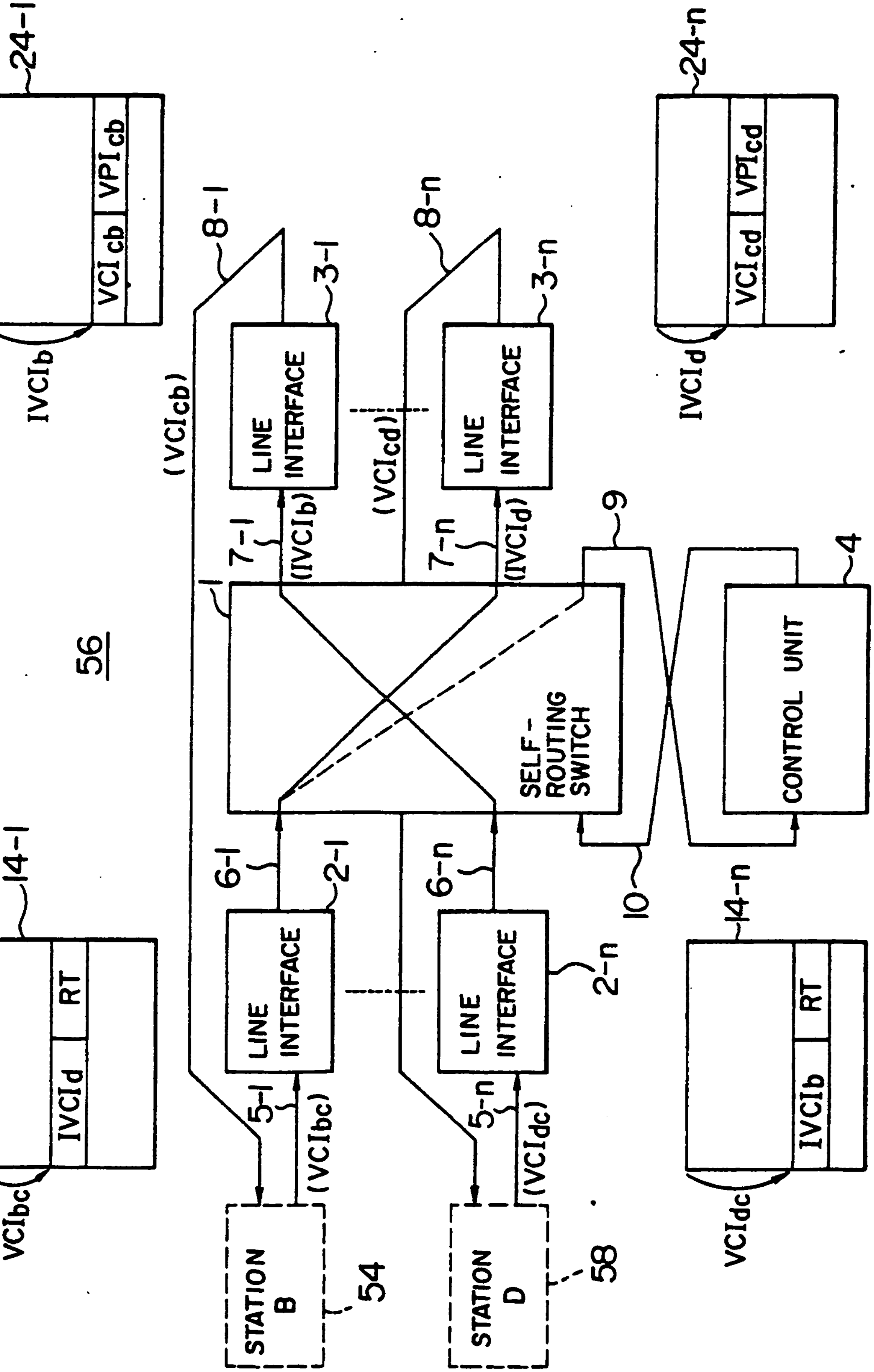
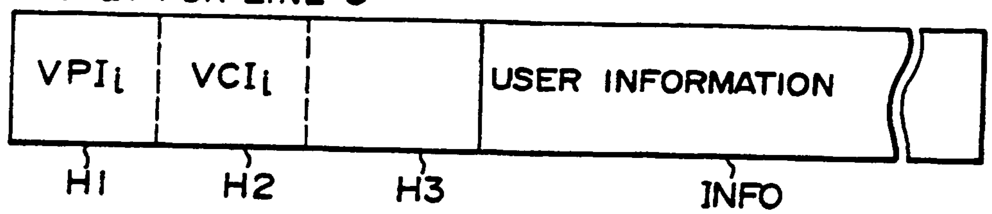

56
24-1
VCIcb
VPIcb
IVCIb
24-n
VCIcd
VPIcd
IVCId
8-1
8-n
3-1
3-n
LINE INTERFACE
LINE INTERFACE
(VCIcb)
(VCIcd)
7-1
(IVCIb)
7-n
(IVCId)
9
4
1
SELF-ROUTING SWITCH
CONTROL UNIT
14-1
IVCId
RT
VCIbc
14-n
IVCIb
RT
VCIdc
6-1
2-1
6-n
2-n
10
LINE INTERFACE
LINE INTERFACE
5-1
(VCIbc)
5-n
(VCIdc)
STATION B
54
STATION D
58

FIG. 4

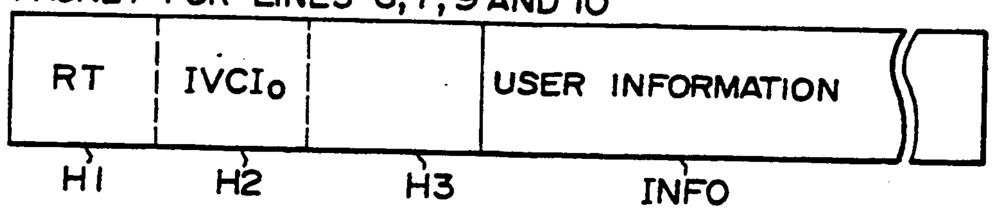
PACKET FOR LINE 5

F I G. 5A



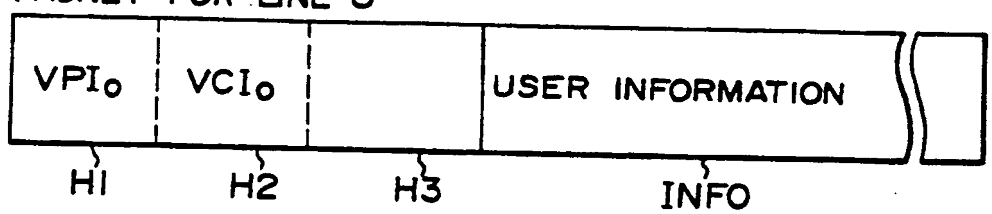
PACKET FOR LINES 6, 7, 9 AND 10

F I G. 5B

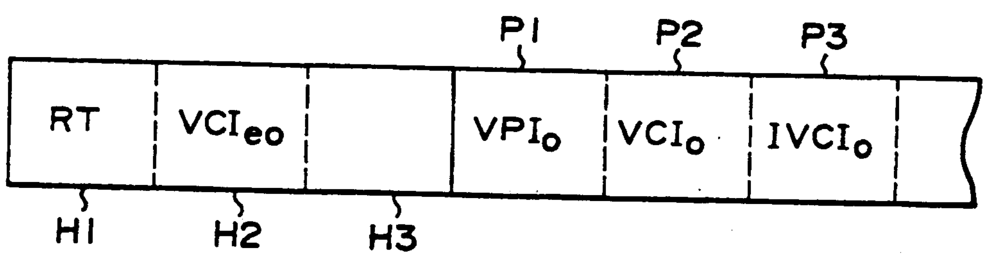


PACKET FOR LINE 8

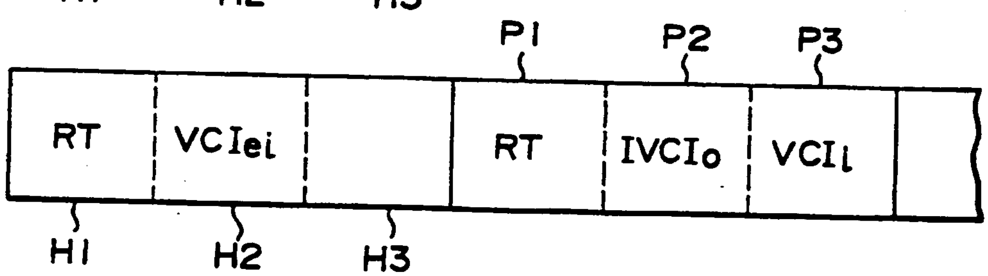
F I G. 5C



F I G. 6A



F I G. 6B



F I G. 7

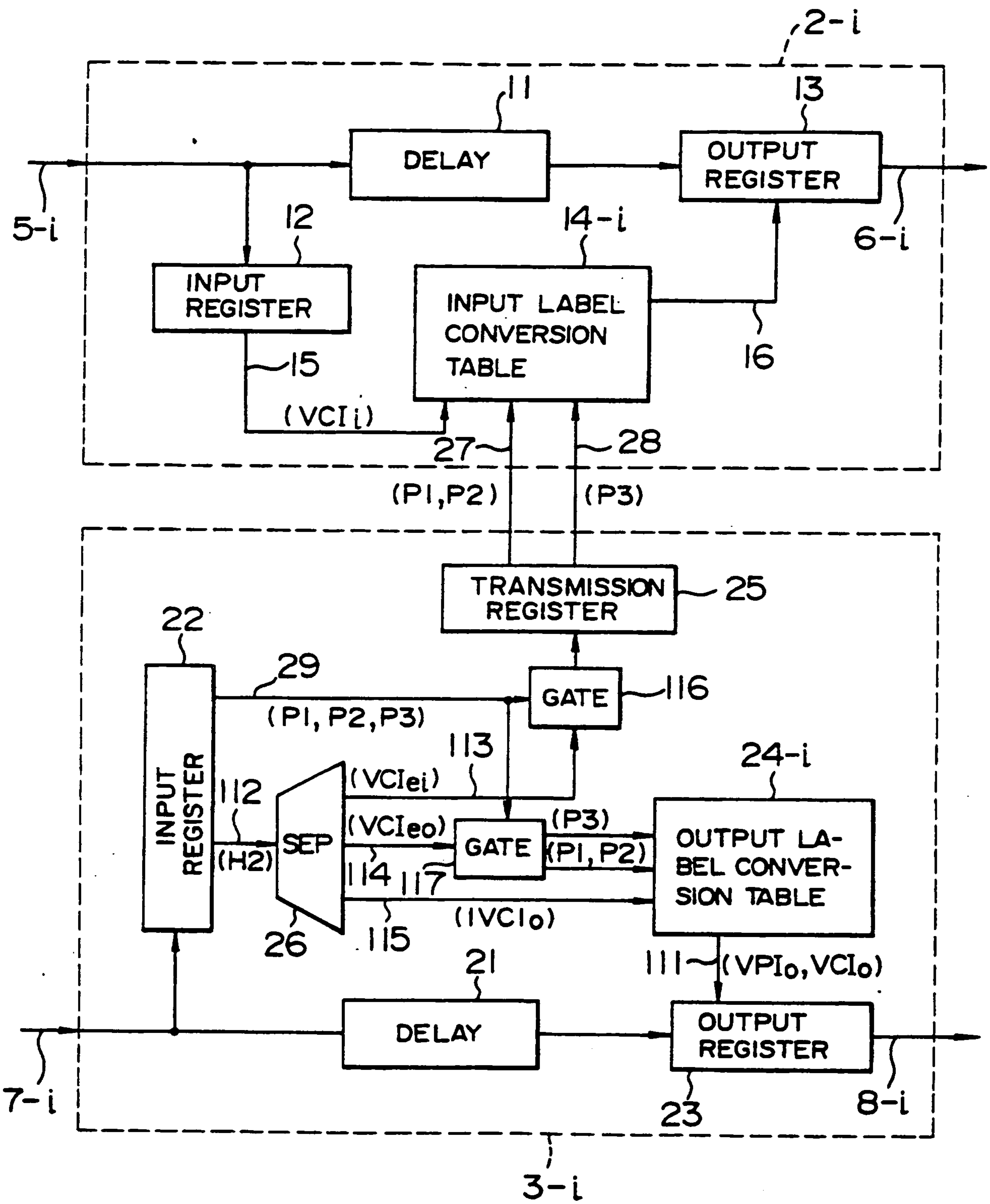

2-i
11
13
DELAY
OUTPUT REGISTER
5-i
12
14-i
6-i
INPUT REGISTER
INPUT LABEL CONVERSION TABLE
15
16
(VCIi)
27
28
(P1,P2)
(P3)
TRANSMISSION REGISTER
25
22
29
GATE
116
(P1, P2, P3)
113
24-i
INPUT REGISTER
112
(VCIei)
SEP
(VCIeo)
GATE
(P3)
(H2)
(P1, P2)
OUTPUT LABEL CONVERSION TABLE
114
117
(IVCIo)
26
115
21
111
(VPIo, VCIo)
DELAY
OUTPUT REGISTER
7-i
23
8-i
3-i

FIG. 8

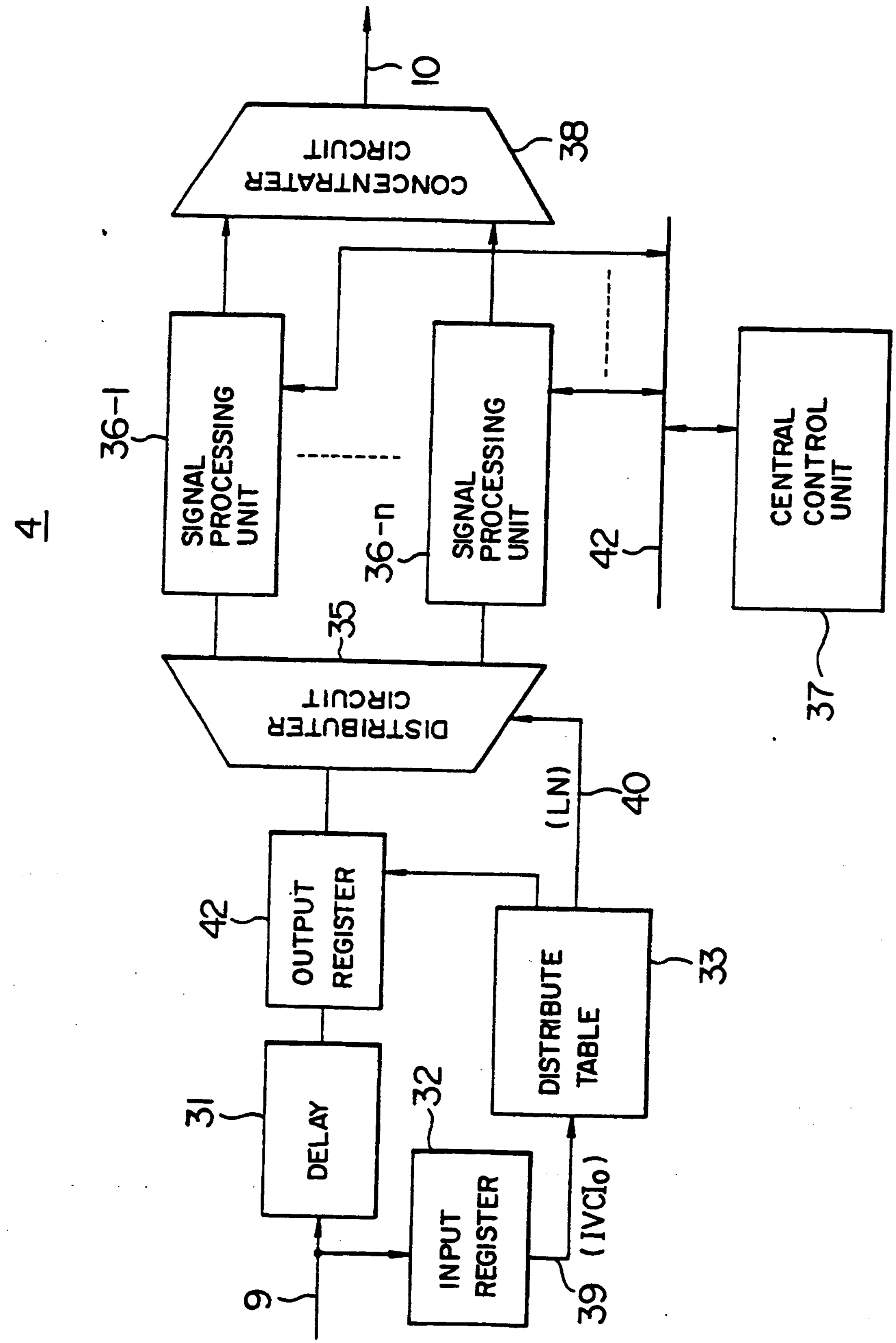

4
DELAY
INPUT REGISTER
OUTPUT REGISTER
DISTRIBUTE TABLE
DISTRIBUTER CIRCUIT
SIGNAL PROCESSING UNIT
SIGNAL PROCESSING UNIT
CONCENTRATER CIRCUIT
CENTRAL CONTROL UNIT
(IVCIo)
(LN)
9
10
31
32
33
35
36-1
36-n
37
38
39
40
42
42

FIG. 9

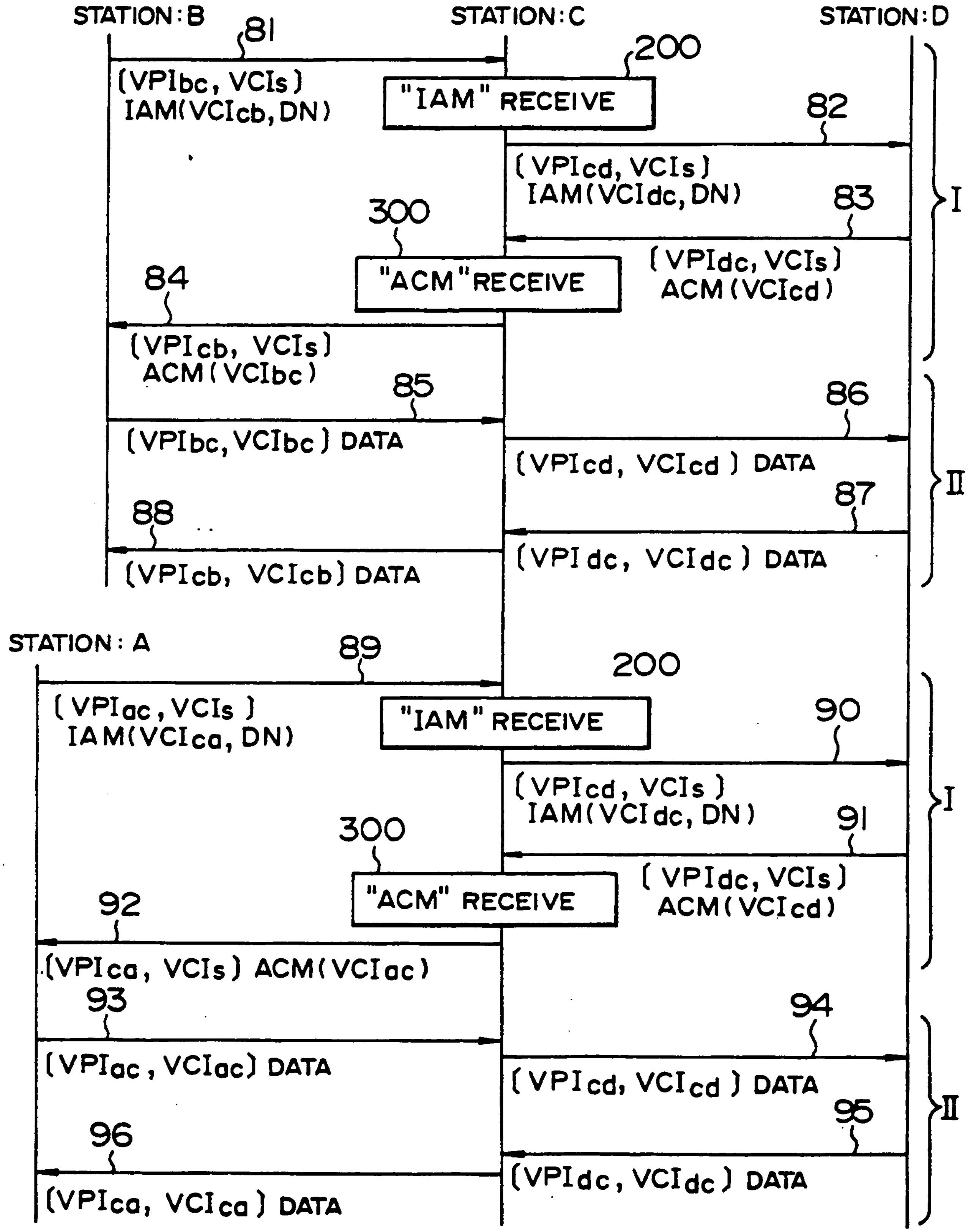

STATION:B
STATION:C
STATION:D
81
200
(VPIbc, VCIs)
IAM(VCIcb, DN)
"IAM" RECEIVE
82
(VPIcd, VCIs)
IAM(VCIdc, DN)
83
300
(VPIdc, VCIs)
ACM(VCIcd)
84
"ACM" RECEIVE
I
(VPIcb, VCIs)
ACM(VCIbc)
85
86
(VPIbc, VCIbc) DATA
(VPIcd, VCIcd) DATA
87
II
88
(VPIdc, VCIdc) DATA
(VPIcb, VCIcb) DATA
STATION: A
89
200
(VPIac, VCIs)
IAM(VCIca, DN)
"IAM" RECEIVE
90
(VPIcd, VCIs)
IAM(VCIdc, DN)
91
I
300
(VPIdc, VCIs)
ACM(VCIcd)
92
"ACM" RECEIVE
(VPIca, VCIs) ACM(VCIac)
93
94
(VPIac, VCIac) DATA
(VPIcd, VCIcd) DATA
95
II
96
(VPIdc, VCIdc) DATA
(VPIca, VCIca) DATA

FIG. 10

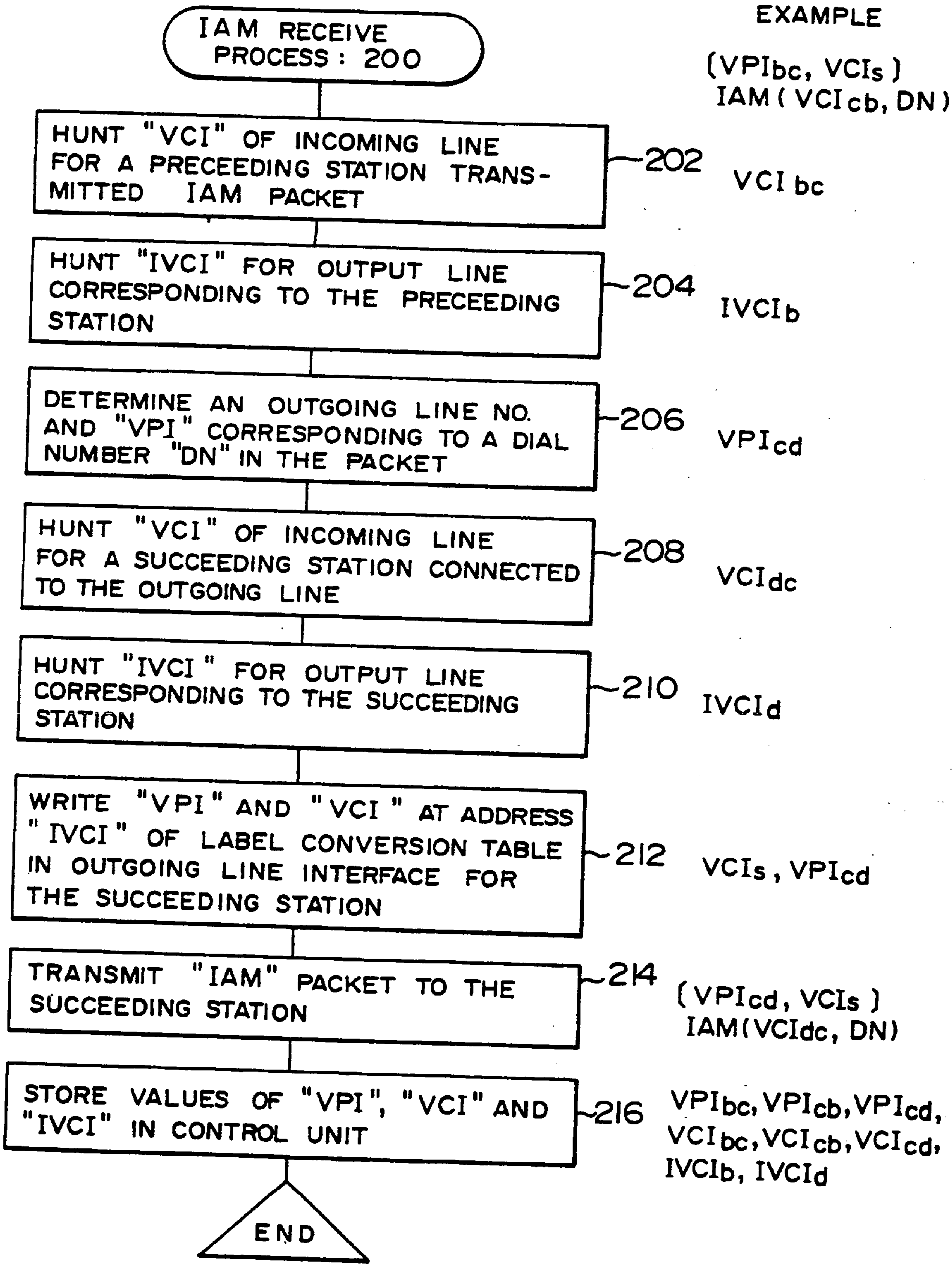
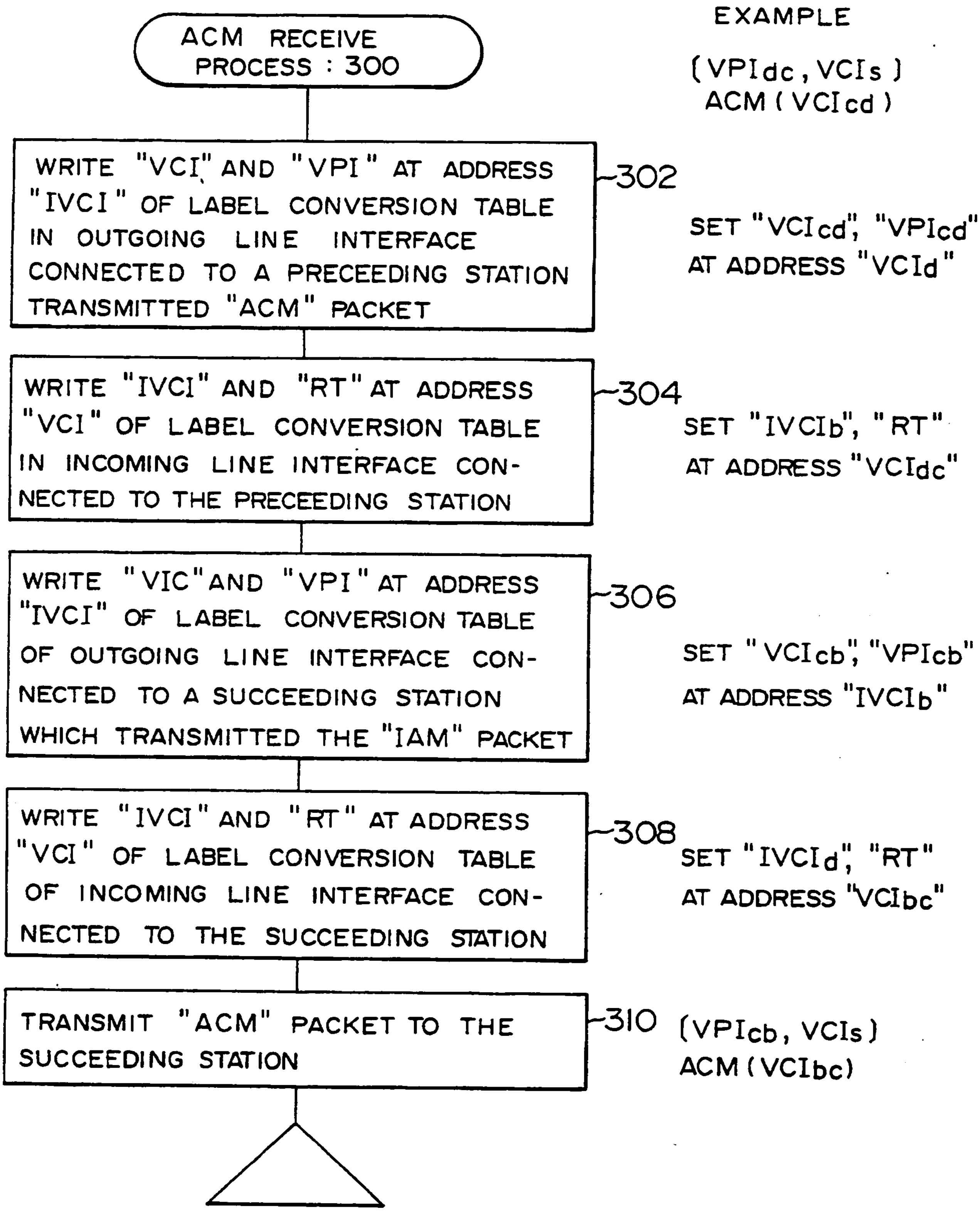

IAM RECEIVE PROCESS : 200
EXAMPLE
(VPIbc, VCIs)
IAM (VCIcb, DN)
HUNT "VCI" OF INCOMING LINE FOR A PRECEEDING STATION TRANSMITTED IAM PACKET
202
VCI bc
HUNT "IVCI" FOR OUTPUT LINE CORRESPONDING TO THE PRECEEDING STATION
204
IVCIb
DETERMINE AN OUTGOING LINE NO. AND "VPI" CORRESPONDING TO A DIAL NUMBER "DN" IN THE PACKET
206
VPIcd
HUNT "VCI" OF INCOMING LINE FOR A SUCCEEDING STATION CONNECTED TO THE OUTGOING LINE
208
VCIdc
HUNT "IVCI" FOR OUTPUT LINE CORRESPONDING TO THE SUCCEEDING STATION
210
IVCId
WRITE "VPI" AND "VCI" AT ADDRESS "IVCI" OF LABEL CONVERSION TABLE IN OUTGOING LINE INTERFACE FOR THE SUCCEEDING STATION
212
VCIs, VPIcd
TRANSMIT "IAM" PACKET TO THE SUCCEEDING STATION
214
(VPIcd, VCIs)
IAM(VCIdc, DN)
STORE VALUES OF "VPI", "VCI" AND "IVCI" IN CONTROL UNIT
216
VPIbc, VPIcb, VPIcd,
VCIbc, VCIcb, VCIcd,
IVCIb, IVCId
END

FIG. 11



EXAMPLE
ACM RECEIVE PROCESS : 300
(VPIdc, VCIs)
ACM (VCIcd)
WRITE "VCI" AND "VPI" AT ADDRESS "IVCI" OF LABEL CONVERSION TABLE IN OUTGOING LINE INTERFACE CONNECTED TO A PRECEEDING STATION TRANSMITTED "ACM" PACKET
302
SET "VCIcd", "VPIcd" AT ADDRESS "VCId"
WRITE "IVCI" AND "RT" AT ADDRESS "VCI" OF LABEL CONVERSION TABLE IN INCOMING LINE INTERFACE CONNECTED TO THE PRECEEDING STATION
304
SET "IVCIb", "RT" AT ADDRESS "VCIdc"
WRITE "VIC" AND "VPI" AT ADDRESS "IVCI" OF LABEL CONVERSION TABLE OF OUTGOING LINE INTERFACE CONNECTED TO A SUCCEEDING STATION WHICH TRANSMITTED THE "IAM" PACKET
306
SET "VCIcb", "VPIcb" AT ADDRESS "IVCIb"
WRITE "IVCI" AND "RT" AT ADDRESS "VCI" OF LABEL CONVERSION TABLE OF INCOMING LINE INTERFACE CONNECTED TO THE SUCCEEDING STATION
308
SET "IVCId", "RT" AT ADDRESS "VCIbc"
TRANSMIT "ACM" PACKET TO THE SUCCEEDING STATION
310
(VPIcb, VCIs)
ACM (VCIbc)

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(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 406 842 A3**

(12) **EUROPEAN PATENT APPLICATION**

(21) Application number: **90112790.2**

(51) Int. Cl.⁵: **H04L 12/56**, H04L 29/06

(22) Date of filing: **04.07.90**

(30) Priority: **05.07.89 JP 171789/89**

(43) Date of publication of application: **09.01.91 Bulletin 91/02**

(84) Designated Contracting States: **DE FR GB**

(88) Date of deferred publication of the search report: **05.05.93 Bulletin 93/18**

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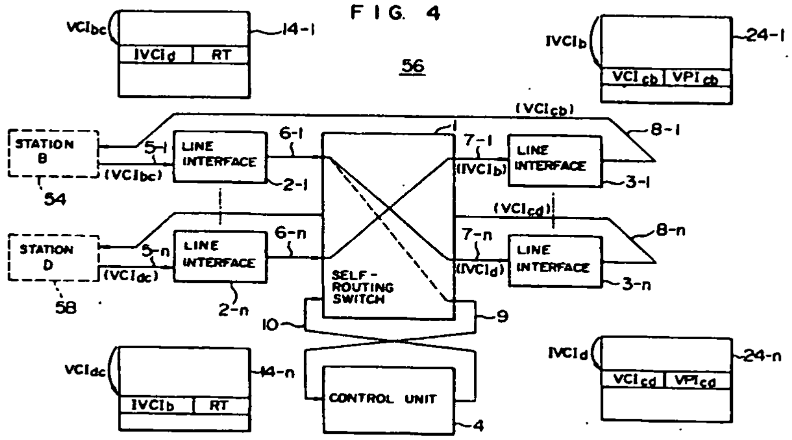
(54) **Packet switch network for communication using packet having virtual connection identifier VCI.**

(57) In a packet network which includes a plurality of packet switching stations (52, 54, 56, 58) and in which a packet including in its header portion a VPI (Virtual Path Identifier) for identifying one of logical paths multiplexed on a transmission line and VCI (Virtual Connection Identifier) for identifying one of logical connections multiplexed on one logical path is communicated between the switching stations, each switching station preliminarily designates a VCI to be given to a packet directed to that station when a logical connection is to be set up between that station and another station. When receiving an information packet from the other station, the each station makes access to header label conversion tables (14, 24) on the basis of a VCI included in the received packet to read internal routing information necessary for a packet switching operation and a VCI to be given to a packet to be delivered.

F I G. 4



EP 0 406 842 A3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 90 11 2790

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	AU-A-2 507 388 (NEC CORPORATION) * page 3, line 21 - page 4, line 15; claims 1-3; figures 1-3 * ---	1-7	H04L12/56 H04L29/06
A	EP-A-0 279 443 (FUJITSU) * column 1, line 50 - column 4, line 16 * ---	1-7	
A	WO-A-8 400 267 (WESTERN ELECTRIC COMPANY) * column 4, line 33 - column 5, line 18 * * column 7, line 32 - column 8, line 10 * ---	1-7	
A	EP-A-0 234 191 (NEC) * column 3, line 45 - column 10, line 28 * ---	-	
A	GB-A-2 168 222 (KOKUSAI DENSHIN DENWA CO LTD) * page 2, line 60 - page 3, line 86 * -----	-	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			H04L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	03 MARCH 1993	STAESSEN B.F.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
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P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document